GD-ROM Protocol
SPI (Sega Packet Interface) Specifications

Issued:			
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Changes made from Ver 1.21 to 1.22

- Modified shape transfer picture in according to the current drive.
- Added notes on command flow when data transmission amount is 0.

Changes from version 1.20 to version 1.21

- Single-density and double-density specification was added to GET_TOC command, with separate get procedure.

Changes from version 1.12 to version 1.20

- Protocol name set to SPI (Sega Packet Interface), ATA commands in protocol changed to SATA.
- Explanation of Feature register added.
- Control/Address sequence as shown in data for CD_SCD command corrected (was reversed from GET_TOC command).
- ECC Retry Times deleted from REQ_MODE/SET_MODE command (not supported by chip).
- ADR and Control sequence in data for GET_TOC command adjusted to comply with Yellow Book.
- Other corrections

Changes from version 1.22 to version 1.30

- Explanations added
- Errors corrected

Changes from version 1.30 to version 1.31

- Errors corrected
- Explanations added

Contents

1. Outline

This document describes the interface between the host and KATANA GD-ROM drive.

1.1 System Configuration

- Host interface

  Electrical interface between host and GD block conforms to ATA-3 specifications.

  (Software compatibility is not assured.)

- CD-DA playback capability

  CD-DA playback can be realized easily with commands from the host.

- Data transfer

  High-speed data transfer is possible (max. 16.6 MB/s).

2. Basics

2.1 Terms and Symbols

Terms used in this document are defined below.

Term	Meaning
CD-DA	Compact Disc-Digital Audio Standard media for recording digital audio information, defined by the 'Red Book'
CD-ROM	Compact Disc-Read Only Memory Standard media for recording digital audio and digital data, defined by ISO/IEC 10149.
Command packet	Structure used for transmitting commands from the host to SPI device.
DMA	Data transfer between peripheral ancillary equipment and the host memory without the intermediacy of the processor.
Index	Information that fragments CD-ROM tracks. A track can be allotted an index number from 1 to 99. The index numbers of a track start with 1 and are numbered consecutively.
Lead-in area	Area located before the first track on the disc. The main channel within the lead-in area is audio or 'null' data and it is recorded as track 00. TOC information is recorded in this area's subcode Q.
Lead-out area	The disc's last information track area. The main channel within the lead-out area is audio or 'null' data and it is recorded as track AA (bcd).
PIO	Programmed Input/Output Data transfer mediated by the host processor.
Sector	Data contained in 1 frame (1/75 sec)
Subcode	Data other than main channel data recorded on a CD-ROM or CD-DA. The structure consists of eight data called P, Q, R, S, T, U, V, and W.
TOC	Table Of Contents Information that shows the disc type and start address of tracks. This information is recorded in the subcode Q.
Track	Information that fragments the disc, numbered from 1 to 99. The data within one track must be the same class. It is either CD-ROM or CD-DA.
Frame address (FAD)	Continuous number starting at 0 (absolute time point 00:00:00 on GD). 1:1 relationship to absolute time.
Logical sector number (LSN)	Continuous sector (frame) unit number starting at 0 (absolute time point 00:02:00 on GD). Logical sector number = frame address - 150 (2 seconds)
IDE	Integrated Drive Electronics An interface originally designed for connecting hard drives to IBM PC/AT compatibles.
ATA	AT Attachment A set of hardware and software specifications for IDE, defined by the CAM (Common Access Method) committee.

ATAPI	ATA Packet Interface An expansion of the ATA standard for connecting CD-ROM drives, defined by the SFF (Small Form Factor) committee.
SPI	Protocol that supports the GD-ROM block.
GD	Gigabyte Disc Disc for KATANA use that consists of single-density and double-density areas.
GD-ROM	Gigabyte Disc-Read Only memory Area with data recorded in the double-density area of the KATANA disc.
GD-DA	Gigabyte Disc-Digital Audio Audio area recorded in the double-density area of the KATANA disc.
Task file	A register file for controlling the KATANA GD-ROM block.

Table 2.1 Terms

2.2 Disc Layout

Refer to the "GD-ROM Format Specifications Basics" and the "GD-ROM Format Specifications Applications" supplied separately.

3. Communication Principle

The host and GD drive are connected via an ATA interface. The communication protocol uses ATA commands expanded by original commands.

3.1 SPI Outline

The SPI standard matches the KATANA GD-ROM drive and in a unique way simplifies and expands the ATAPI standard.

3.2 Signal Lines

- CS0- (Chip select 0)
  Serves for selecting the command block register.
  Note: This signal is known as "CS1FX-" in the industry.

- CS1- (Chip select 1)
  Serves for selecting the control block register.
  Note: This signal is known as "CS3FX-" in the industry.

- DA2, DA1, DA0 (Device address)
  Specifies the register and data read/write port.

- DASP- (Device active, device 1 present)
  Time multiplexed signal which indicates whether the device is active and whether device 1 is present.
  The signal in this line is an open collector signal. However, the signal cannot be used by the host.

- DD0 - DD15 (Device data)
  Bidirectional data bus that can be used either as 8-bit or 16-bit bus.
  The 8-bit LSB is used for 8-bit transfer (register etc.).

- DIOR- (Device I/O read)
  Read strobe signal from the host.
  At the falling edge of this signal, the data on the DD0- DD7, DD8-DD15 data bus from the device register or data port become valid. At the rising edge of this signal, the host latches on to the data. Until latching is completed, the host cannot access the data.

- DIOW- (Device I/O write)
  Write strobe signal from the host.
  At the falling edge of this signal, the data on the DD0- DD7, DD8-DD15 data bus from the device register or data port are latched.
  Until latching is completed, the device cannot access the data.

- DMACK- (DMA acknowledge) (optional)

  This signal is used by the host in response to DMARQ, for initiating a DMA transfer.

- DMARQ- (DMA request) (optional)

  This signal is used for DMA transfer between the host and this device. When data transfer is possible, the device drives the signal.

  The data transfer direction is controlled by the DIOR- and DIOW- commands.

  This signal is used in handshaking with the DMACK- signal.

  When no device is selected and when no DMA commands are being executed, the signal line is always in the high- impedance (release) state.

  When DMA transfer is being carried out, the signal is driven by the device.

- INTRQ (Device interrupt)

  Serves for issuing an interrupt to the host. The INTRQ signal has a hold function which asserts the interrupt only when the device is selected and the host has cleared the nIEN bit in the device control register.

  When the nIEN bit is "1", or when the device is not selected, the INTRQ signal is in the high-impedance state, regardless of the presence of the hold interrupt.

  In the interrupt hold state, the following OR conditions are cleared.

  - RESET signal assertion
  - Device control register SRSRT bit reset
  - When host has written to command register
  - When host has read from command register

  For PIO transfer, the INTRQ signal is asserted at the start of each transferred data. The data block is normally a single sector, unless declared otherwise by a separate method.

  For DMA transfer, the INTRQ signal is asserted only once, after the command has terminated.

- IOCS16- (Device 16-bit I/O)

  For PIO transfer in mode 0, 1, or 2, the IOCS16- signal indicates that the 16-bit data port is already addressed and that the device can send and receive 16-bit data.

  This is an open collector output.

  - In any PIO mode, the device supports only 16-bit data transfer. Therefore the IOCS16- signal is always asserted.
  - During DMA mode transfer, the host uses the 16-bit DMA channel and the IOCS16- signal is not asserted.

  However, the signal cannot be used by the host.

- IORDY (I/O channel ready)
  When the device cannot comply with a data transfer request, the signal is negated in order to expand the register access host transfer cycles.

  When this signal is driven, it is valid only during the DIOR-/DIOW- cycle for the selected device.

  When the IORDY signal is not negated, it is in the high- impedance state, because it is an open collector signal.

- RESET (Device reset)
  This signal is issued by the host. It is asserted at the start of power-on, and the assert state is maintained until the power supply level has stabilized. This is a tolerance interval until device reset after power-on.
- MCK (Main clock)
  33.8688 MHz clock signal for AICA use.
- BCLK (Bit clock)
  Clock signal for fetching Digital Audio.
- LRCK (Left right clock)
  Digital Audio left/right discriminant signal.
- SDTATA (Serial data)
  Digital Audio data.
- EMPH (Emphasis)
  A High output signal is obtainable if preemphasis is applied to Digital Audio during playback or scan playback. Should there be irregularities in the subcode Q data during playback, the value of the previous time is retained and output. Low is output when power is turned ON, when reset, when playback is stopped, when the lid is open and when no disc is inserted.

3.3 Command Transfer Mechanism

3.3.1 Reset Conditions

There are three types of reset conditions to which the SPI device responds.

- Power-on reset or hardware reset

  In the same way as executing the master/slave diagnosis protocol, the electrical circuit diagnosis is executed and the default values are established.

- SPI Soft Reset

  When the SPI device receives a SPI Soft Reset command, the interface circuit is reset to an interface that operates with the characteristics requested by Set Features.

- ATA SRST

  The device normally supplies the ATA PDIAG/DASP sequence and executes the task file associated with the command when SRST is detected.

  This does not cause an actual device reset. There are no startup, abort, or stop commands.

The order of the reset conditions listed above is also the priority order. Power-on or hard reset has priority over SPI Soft Reset, and SPI Soft Reset has priority over ATA SRST. ATA SRST has priority over all other states except those listed above.

3.3.1.1 Power-On Reset or Hardware Reset

When the device is powered, an internal reset and test routine is carried out. When the device detects a reset, the following actions are performed:

(1) All currently executing commands and I/O operations are cleared.

(2) The device is reset to the default condition.

(3) As after normal power-on reset, the operation mode of the device returns to a suitable initial state.

(4) The task file register is initialized as follows.

Status = 00h, Error = 01h, Sector Count = 01h, Sector Number = 01h, Cylinder Low = 14h, Cylinder High = EBh, Drive/Head = 00h

BSY = 0 following after any reset indicates that the task file register is already initialized for the host.

3.3.1.2 SPI Soft Reset Command and Protocol

The SPI specifications require a software reset function. This serves as a recovery mechanism for errors or other problems that cannot be removed by other methods.

A valid software reset must be able to return the microprocessor of the device from the busy or hung-up state to the diagnosis state and a state where other commands can be performed.

Because the microprocessor is the reset target, it cannot be used as a part of the reset path. Therefore the software reset is detected and decoded by the interface controller circuit and returned to the microprocessor as a hardware signal. It can therefore be issued even when the BSY bit is 1.

When the software reset command is detected, the following sequence is performed.

(1) The BUSY state is set. When the reset sequence in the device is completed, the BUSY state is also cleared. This is the only status that is reported to the host during an SPI Software Reset.

(2) The same information sequence as after power-on reset is performed and the task file is initialized. As an exception, the DRV bit remains unchanged.

3.3.1.3 ATA SRST

The ATA software reset mechanism SRST (device control register, bit 2) is not used for this device.

3.4 ATA I/O Register

Communication between the device and the host occurs via the I/O register selected by the code data on the signal from the host (CS0-, CS1-, DA2, DA1, DA0, DIOR-, DIOW-). Except for the data register, all registers are read and written in byte units (8 bits).

The data register is always accessed in 16-bit words.

Table 3.1 I/O Port Functions and Selection Addresses

Addresses					Functions	
CS0-	**CS1-**	**DA2**	**DA1**	**DA0**	**READ (DIOR-)**	**WRITE (DIOW-)**
N	N	x	x	x	Data bus high imped	Not Used
					Control Block Registers	
N	A	0	x	x	Data bus high imped	Not Used
N	A	1	0	x	Data bus high imped	Not Used
N	A	1	1	0	Alternate status	Device control
					Command Block Registers	
A	N	0	0	0	Data	Data
A	N	0	0	1	Error Register	Features
A	N	0	1	0	Interrupt Reason Register	Not used
A	N	0	1	1	Sector Number	Not used
A	N	1	0	0	Byte Count Register bits 0-7	Byte Count Register bits 0-7
A	N	1	0	1	Byte Count Register bits 8-15	Byte Count Register bits 8-15
A	N	1	1	0	Drive Select	Drive Select
A	N	1	1	1	Status	Command
A	A	x	x	x	Invalid address	Invalid address
Logic conventions are: A = signal asserted, N = signal negated, x = don't care						

- Status register

  This register indicates the drive status. When the register is read, any pending interrupt signal is cleared.

  When bit 7 (BSY) is "0", the other bits are also valid and the command block can be accessed. When the bit is "1", the other bits are invalid and the command block cannot be accessed. However, in the case of special commands (NOP, Soft Reset command, etc.) access to the command block is enabled even when this bit is "1".

  Bit 7 (BSY) becomes valid 400 ns after a command is received.

7	6	5	4	3	2	1	0
BSY	DRDY	DF	DSC	DRQ	CORR	Reserved	CHECK

Bit 7 (BSY): BSY is always set to "1" when the drive accesses the command block.

Bit 6 (DRDY): Set to "1" when the drive is able to respond to an ATA command.

Bit 5 (DF): Returns drive fault information.

Bit 4 (DSC): Becomes "1" when seek processing is completed.

Bit 3 (DRQ): Becomes "1" when preparations for data transfer between drive and host are completed. Information held in the Interrupt Reason Register becomes valid in

the packet command when DRQ is set.

Bit 2 (CORR): Indicates that a correctable error has occurred.

Bit 0 (CHECK): Becomes "1" when an error has occurred during execution of the command the previous time.
Error details can be determined by checking the sense key and error code.

- Alternate Status Register

  This register is the same as the status register, but it does not clear DMA status information when it is accessed.

7	6	5	4	3	2	1	0
BSY	DRDY	DF	DSC	DRQ	CORR	Reserved	CHECK

  For information on the meaning of the bits, refer to the explanation of the status register.

- Command Register
  Commands from the host are set in this register. For information on the meaning of commands, refer to the Table 3.3.

- Byte Count Register
  This register serves for controlling the number of bytes sent from the host in response to the DRQ commands.
  It is used only in PIO mode. In DMA mode, the Byte Count Register contents are disregarded. The register is set before a packet command is issued. The register determines the total transfer amount of the data sent in response to one data group transfer command (REC_MODE/SET_MODE, REQ_STAT, etc.).
  For commands which require several DRQ interrupts (CD_READ, CD_READ2, etc.), the expected data length is set in this register.
  When any data are to be transferred, the device sets the number of bytes to be transferred by the host in the Byte Count Register and then issues the DRQ interrupt. The contents of the register do not change unless at least one word or more is transferred from the data register.

- Data Register
  This register is used for reading and writing during data transfer with the host. The register is switchable between 8 and 16 bits. However, only 16-bit mode is supported because the host is not using the IOCS-16 signal.

- Device Control Register
  Bit 2 (SRST) of this register is the reset switch from the host, but it is not used in the current protocol. When wishing to perform a software reset, use the "Software Reset" command as defined in the SPI protocol. Bit 1 (nIEN) determines whether the host interrupt is made valid or not.

7	6	5	4	3	2	1	0
Reserved				1	SRST	nIEN	0

  Bit 2 (SRST): Software reset from host. The default is "0". Reset is performed when set to "1". However, because this is not used in this protocol use the "SPI Software Reset" command defined in SPI for performing a software reset.

Bit 1 (nIEN): Sets the interrupt for the host. The default is "0". Invalid can be selected by setting this to "1".

- Drive select register(ATA Drive/Head select register)

7	6	5	4	3	2	1	0
1	Reserved	1	0	LUN			

Bit 0-3 (LUN): Logical unit number to which the command is applied.
(This parameter is optional and reserved for future use.)

- Error register

The completion status of the most recent command is set in this register, also at the end of hard disk diagnosis. When the status register bit 0 is "1", an error has occurred, and the error content is set in this register.

7	6	5	4	3	2	1	0
Sense Key				MCR	ABRT	EOMF	ILI

Bits 7 - 4: Sense key. For details, refer to the Table 3.2. The Sense Key is only reflected in the SPI command mode, the same is true for ASC (Additional Sense Code), ASCQ (Additional Sense Code Qualifier).
Bit 3 (MCR): Media change was requested and media have been ejected (ATA level).
Bit 2 (ABRT): Drive is not ready and command was made invalid (ATA level).
Bit 1 (EOM): Media end was detected (option).
Bit 0 (ILI): Command length is not correct (option).

- Features register

This register normally specifies the data transfer mode, but it can also be used for Set Features parameters of the ATA command. When issuing commands accompanied by data transfer, such as CD_READ, specify in this register whether data should be transferred by PIO or DMA at the time of task file initialization.

Normal use (specify data transfer mode)

7	6	5	4	3	2	1	0
Reserve							DMA

Bit 0 (DMA): Send data for command in DMA mode.

Use as parameter for Set Features command

7	6	5	4	3	2	1	0
Set(1)/ Clear(0) Feature	Feature Number						

Bit 6 - 0 (Feature Number): Set transfer mode by setting to 3.

By writing "3" as Feature Number and issuing the Set Feature command, the PIO or DMA transfer mode set in the Sector Count register can be selected.

The actual transfer mode is specified by the Sector Counter Register.

- Interrupt reason register (Read Only)

7	6	5	4	3	2	1	0
Reserved						IO	CoD

Bit 0 (CoD): "0" indicates data and "1" indicates a command.

Bit 1 (IO): "1" indicates transfer from device to host, and "0" from host to device.

IO	DRQ	CoD	
0	1	1	Command packet can be received.
1	1	1	Message can be sent from device to host.
1	1	0	Data can be sent to host.
0	1	0	Data can be received from host.
1	0	1	Status register contains completion status.

- Sector Count Register (Write Only)

7	6	5	4	3	2	1	0
Transfer Mode				Mode Value			

Transfer mode according to Sector Count Register value

00000 00x	PIO Default Transfer Mode
00001 xxx	PIO Flow Control Transfer Mode x
00010 xxx	Single Word DMA mode x
00100 xxx	Multi-Word DMA
00011 xxx	Reserved (For Pseudo DMA mode)

This register is used in combination with the ATA command's Set Features command.

- Sector Number Register (ATA Sector Number Register)

7	6	5	4	3	2	1	0
Disc Format				Status			

The information obtained by this register is the same as the status data obtained with the REQ_STAT command.

Disc Format becomes valid after the lid is closed and the UNIT ATTENTION state is entered via the NOT READY state, or after the BSY bit becomes "0" following Soft Reset.

Status becomes valid after the power is turned ON and the UNIT ATTENTION state is entered via the NOT READY state, or after the BSY bit becomes "0" following Soft Reset.

The values of this register are invalid during issue of a command and during execution of a command.

The modification timing of this register and the status modification timing caused by REQ_STAT coincide internally but depending on the timing of the read out of the Sector Number Register and the issue of the REQ_STAT command there may be times where they do not coincide.

Also, this register is updated unsyncronized with the host. For this reason, it may return unfixed value if it is read at the timing of updating GD drive side. To avoid this, either read it again to confirm value or use REQ_STAT command instead of this register.

For details on the Disc Format and Status, refer to the sections on GD Drive State Transition and REQ_STAT.

Operation of this register differs from ATA specifications.

Table 3.2 Sense Key Definitions

Sense key	Description
0h	No sense key information (NO SENSE). Indicates that no sense key information is present. This also applies when command execution was successful.
1h	Recovered error (RECOVERED ERROR). The last command has performed successful error recovery processing. Details can be obtained by checking the additional sense byte and the information field. If several error processing operations were performed for one command, the device reports the status of the last error processing operation.
2h	Not ready (NOT READY). Indicates that the device cannot be accessed.
3h	Media error (MEDIUM ERROR). Indicates that the command was terminated unsuccessfully due to a non-recoverable media defect or an error during reading or writing. This sense key may also returned by the device when it is not possible to distinguish between a media defect and a hardware defect (sense key 4).
4h	Hardware error (HARDWARE ERROR). During operation or self- diagnosis, an unrecoverable hardware error was detected (for example a controller failure, device failure, parity error etc.).
5h	Illegal request (ILLEGAL REQUEST). An illegal parameter was included in the command packet or in additional data for commands. When the device detects an illegal parameter in a command packet, it terminates the command without changing the media. When the device detects an illegal parameter in additional data for commands, the device may already have altered the media. When this sense key is reported, the command is not yet executed.
6h	Unit attention (UNIT ATTENTION). Indicates that removable media may have been replaced, or that the device was reset.
7h	Data protect (DATA PROTECT). Indicates that a write attempt was made on a protected block.
8h-Ah	Reserved
Bh	Aborted command (ABORTED COMMAND). Indicates that the device has aborted the command. Recovery may be possible by re-executing the command.
Ch-Fh	Reserved

4 ATA Command Flow Sequence

4.1 Flow of the command for PIO data transfer to host system

This class applies to the following command.

- Identify Device

Execution of this class of commands is accompanied by transfer of one or multiple data blocks from the device to the host. The following steps describe the process of PIO data transfer to the host system but the description does not encompass all the possible error conditions.

a) The host continues to read the Status or Alternate Status Register until the BSY bit becomes "0".
b) The host writes the necessary parameters for the commands to be issued to the Features, Sector Count, Sector Number, Cylinder High, Cylinder Low, Device/Head Register.
c) The host writes the command code to the Command Register.
d) The device sets the BSY bit to "1" and completes the preparations for executing the command containing the preparations for sending the first block of data to the host.
e) When the data block is prepared, the device sets the DRQ bit (when error conditions occur, setting of the DRQ bit is optional). If an error condition has occurred, the device sets an appropriate status and error bit that corresponds to the error condition. Finally, the device asserts INTRQ after clearing the BYS bit.
   Note: When the operation to set the BSY bit in step f) and clearing the BSY bit in step g) is accomplished very fast, the host may not always notice that the BSY bit was set once.
f) After polling the Alternate Status Register and waiting for the BSY bit to become "0", or after detecting INTRQ, the host reads out and saves the contents of the Status Register.
g) If the DRQ bit was set, the host reads out and transfers one block Data Register from the Data Register. If an error condition has occurred in the status read-out of step h), the data transfer will not be legal.
h) When the Status Register is read out, the device negates INTRQ. After read-out of one entire data block, one of the following operations is executed.
   - If status has been communicated to the host without any errors occurring in step h), and transmission of further blocks is required, the device sets the BSY bit and repeats the above sequence from step g).
   - If an error status was reported during read-out of the status in step h), the device clears the DRQ bit and completes the execution of the command.
   - When the final block is transferred, the device clears the DRQ bit and completes the execution of the command.

4.2 Non-data Command Flow

This class applies to the following commands:

- NOP
- Soft Reset
- Execute Device Diagnostic
- Set Features

Execution of this class of commands is not accompanied by data transfer. The following steps describe the non-data transfer command process but the description does not encompass all the possible error conditions.

a) The host continues to read the Status or Alternate Status Register until the BSY bit becomes "0".
b) The host writes the necessary parameters for the commands to be issued to the Features, Sector Count, Sector Number, Cylinder High, Cylinder Low, Device/Head Register
c) The host writes the command code to the Command Register
d) The device sets the BSY bit to "1" and executes the command. If an error has occurred during execution of the command, the device sets an appropriate status and error bit that corresponds to the error condition
e) When the command execution is completed, the device asserts INTRQ after the device has cleared the BSY bit. At this point, execution of the command is completed.

5. ATA Command (Task File Command)

Indicates details regarding such commands out of the ATA specifications that are supported by this device.

To issue a command, the device adds any required parameters, loads the command in a suitable register in the command block, and writes the command code to the command register.

When a command is received, the device sets the BSY bit within 400 ns.

ATA commands that are accepted by the device are listed in Table 3.3. Other commands are reserved and are not used.

Table 3.3 ATA Commands

Command	Code
Soft Reset	08h
Execute Device Diagnostic	90h
NOP	00h
Packet Command	A0h
Identify Device	A1h
Set Features	EFh

- SPI Soft Reset 08h

  Executes a software reset of the device. In contrast to other commands, this command can also be received when BSY = 1.

  When the device receives a "Soft Reset" command, the electrical circuits are initialized and the default parameters are established.

  When the device is currently stopped, disc motor rotation starts and the device is set to the ready state. (See section "Software Reset Command and Protocol".)

- Execute Drive Diagnostic 90h

  This command initiates the self-diagnostic routine of the device.

  (a) The device reports the result of the self-diagnostic routine.

  (b) The device clears the BSY bit and issues an interrupt.

  The error code written to the error register is an 8-bit code as shown below.

Table 3.4 Error Codes

Error Code	Description
01h	Normal
03h	Data buffer error
04h	ODC error
05h	CPU error
06h	DSC error
07h	Other error

- Set Features EFh

  This command controls the device interface timing and sets other protocol parameters. For this device, only the transfer mode settings can be made.

  1. Set 3 in the Set bit of the Feature Register and the Feature Number.
  2. Specify the transfer mode in the upper 5 bits of the Sector Count Register and the mode number in the lower 3 bits.
  3. Execute the Set Features command.

  This setting can be made individually for DMA mode and PIO mode.

- NOP 00h

  This command enables device status access only for hosts with 16-bit register access. Like the SPI Soft Reset command, this command can also be received when BSY = 1 and is provided to terminate the command currently being executed. However, when the termination is performed correctly, only the termination interrupt of this command is returned but it is necessary to pay attention to the fact that if the device issued this command at the point when the command was internally terminated, both the interrupt of the command being executed and the termination interrupt are returned.

  The device responds to commands that are not recognized by the following:

  - Setting "abort" in the error register
  - Setting an error in the status register
  - Clearing "busy" in the status register
  - Asserting the INTRQ signal

- Packet Command A0h

  For details, refer to the "SPI Packet Command" section.

- Identify Device A1h

  Requests information about the connected drive.

  Using the Identify Device command, the host can receive information from the device. Data transfer by the Identify Device command is always conducted in the PIO mode.

Table 3.5 Data returned by Identify Device command

Byte	Content
0	Manufacturer ID
1	Model ID
2	Version ID
3-Fh	Reserved
10h-1Fh	Manufacturer name (16 ASCII characters)
20h-2Fh	Model name (16 ASCII characters)
30h-3Fh	Firmware version (16 ASCII characters)
40h-4Fh	Reserved

6. CD Drive

6.1 CD Drive State Transition

(1) Status and CD drive state

The CD drive status can be checked with the REQ_STAT command or using the Sector Number register.

Table 4.1 CD Drive States

Status	Description
<BUSY>	State transition
<PAUSE>	Pause
<STANDBY>	Standby (drive stop)
<PLAY>	CD playback
<SEEK>	Seeking
<SCAN>	Scanning
<OPEN>	Tray is open
<NODISC>	No disc
<RETRY>	Read retry in progress (option)
<ERROR>	Reading of disc TOC failed (access denied after this)

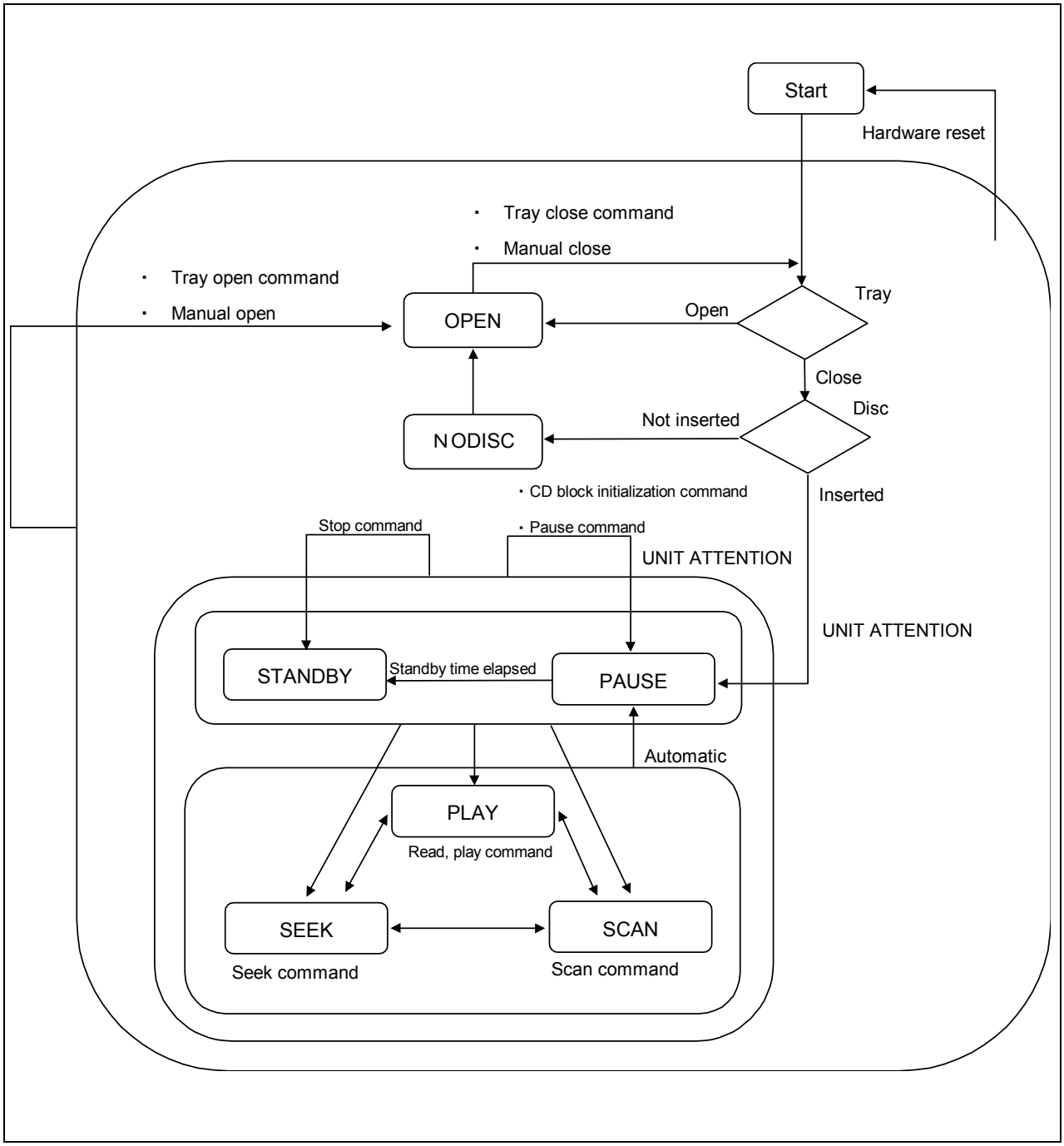
The status becomes <STANDBY> when the disc is removed midway while it is rotating in the condition where the lid is closed.

6.1.1 CD Drive State Transition Diagram

(1) Normal state transition diagram

The normal state transition diagram is shown in Fig. 4.1.

Fig. 4.1 CD Drive State Transition Diagram (normal)



(a) After startup, the drive switches to the <PAUSE> state at the 2-second, 0-frame point (FAD = 150 = 96H) in the case of a CD. On a GD it switches to the <PAUSE> state at the 10 minute and 2-second, 0-frame point.

(b) During state transition (arrow lines), the internal state is the BUSY state.

(c) A "tray close" command is optional. If a tray close command is issued, the drive switches to the <PAUSE> state via the <BUSY> state if a disc is inserted and after the drive has closed the tray. If a disc is not inserted, it switches to the <NODISC> state via the <BUSY> state.

(2) Error state transition diagram

The error state transition diagram is shown in Fig. 4.2.

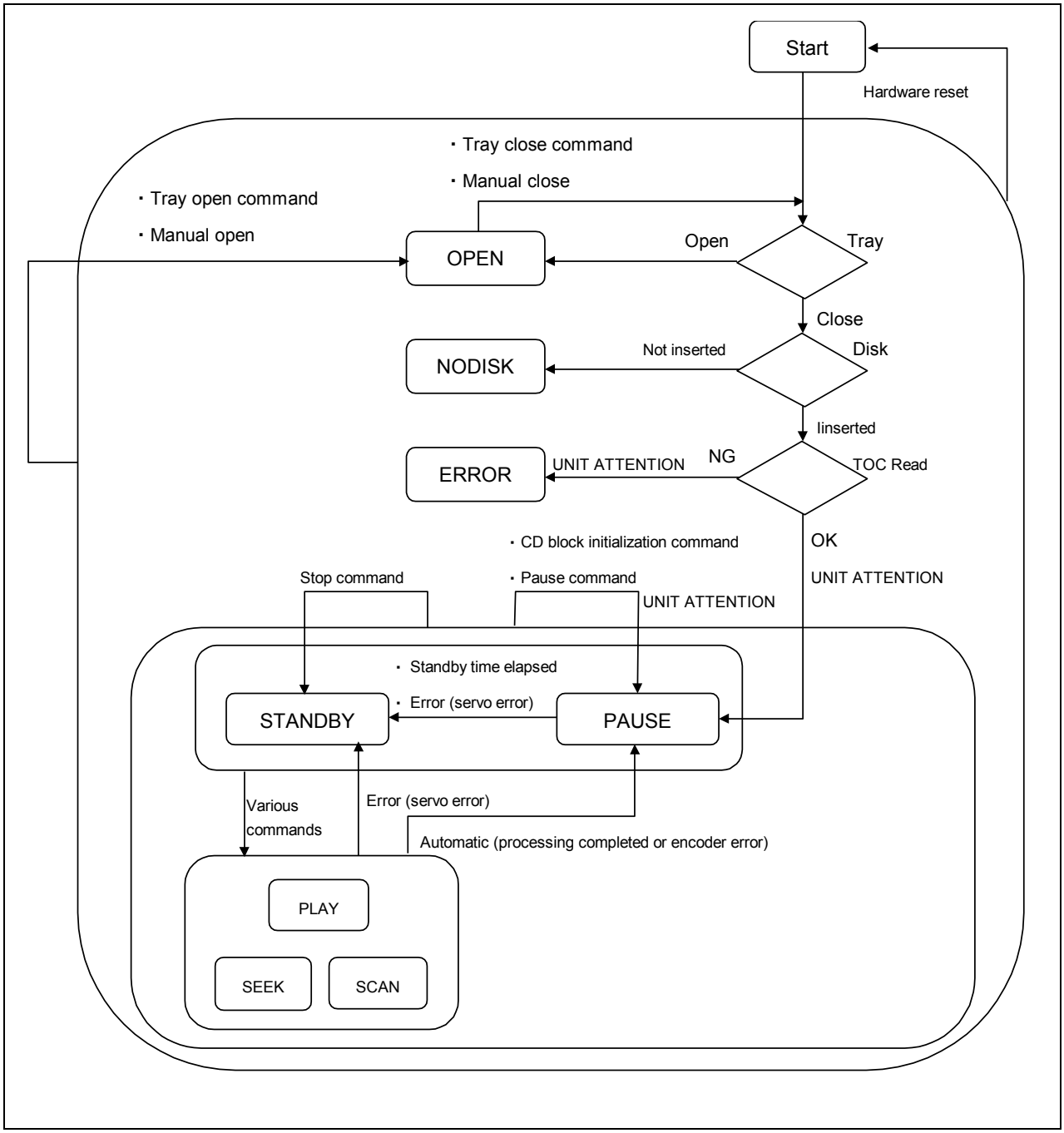


Fig. 4.2 CD Drive State Transition Diagram (error)

Table 4.2 Error State Description

State	Description	Internal state
<RETRY>	Retry successful: PLAY. Retry unsuccessful: error.	SEEK
<ERROR>	Open the lid or the state does not change until the CD_OPEN command is issued.	PAUSE

* Internal state indicates state equivalent to CD block operation.

6.1.2 CD Drive State Transition Table

The CD drive state transition table is shown below. For example, when the pause command is issued in the play state, the pause state is entered.

Table 4.3 CD Drive State Transition

Operation / State	Automatic	Command						
		Initialization	Tray open	Play	Seek	Pause	Stop	Scan
<BUSY>	Change occurs	<PAUSE>	<OPEN>	<PLAY>	<SEEK>	<PAUSE>	<STANDBY>	<SCAN>
<PAUSE>	<STANDBY>	<PAUSE>	<OPEN>	<PLAY>	<SEEK>	<PAUSE>	<STANDBY>	<SCAN>
<STANDBY>	-	<PAUSE>	<OPEN>	<PLAY>	<SEEK>	<PAUSE>	<STANDBY>	<SCAN>
<PLAY>	<PAUSE>	<PAUSE>	<OPEN>	<PLAY>	<SEEK>	<PAUSE>	<STANDBY>	<SCAN>
<SEEK>	<PAUSE>	<PAUSE>	<OPEN>	<PLAY>	<SEEK>	<PAUSE>	<STANDBY>	<SCAN>
<SCAN>	<PAUSE>	<PAUSE>	<OPEN>	<PLAY>	<SEEK>	<PAUSE>	<STANDBY>	<SCAN>
<OPEN>	-	<PAUSE>	<OPEN>	<PLAY>	<SEEK>	<PAUSE>	<STANDBY>	<SCAN>
<NODISC>	-	<NODISC>	<OPEN>	<NODISC>	<NODISC>	<NODISC>	<NODISC>	<NODISC>
<RETRY>	Change occurs	<PAUSE>	<OPEN>	<PLAY>	<SEEK>	<PAUSE>	<STANDBY>	<SCAN>
<ERROR>	-	<PAUSE>	<OPEN>	<PLAY>	<SEEK>	<PAUSE>	<STANDBY>	<SCAN>

* "-" indicates no change.

* In top-loading devices, the OPEN condition does not change even when a command is received.

(1) Commands issued in <BUSY> state

Commands can be accepted also in the <BUSY> state, but they may not be executed immediately.

(However, the tray open command has priority.)

(If the BSY bit is set in the Status Register, no command is accepted.)

(2) Tray open/close

(a) The tray open command is in principle executed immediately under any condition.

(b) In units which are not designed for automatic opening/closing, the tray open/close command causes a <BUSY> state until the action is performed manually.

(c) In the <OPEN> condition, if no disc is inserted, the "NO DISC" state is entered when the tray closes.

(3) Others

When an operation command (such as CD_OPEN, CD_SEEK [STOP, PAUSE]) is executed, it may occur via the <BUSY> state.

7. SPI Command Flow Sequence

7.1 Packet Command Flow For PIO DATA To Host

This class includes the following commands.

- REQ_STAT
- REQ_MODE
- REQ_ERROR
- GET_TOC
- REQ_SES
- CD_READ
- CD_READ2
- GET_SCD

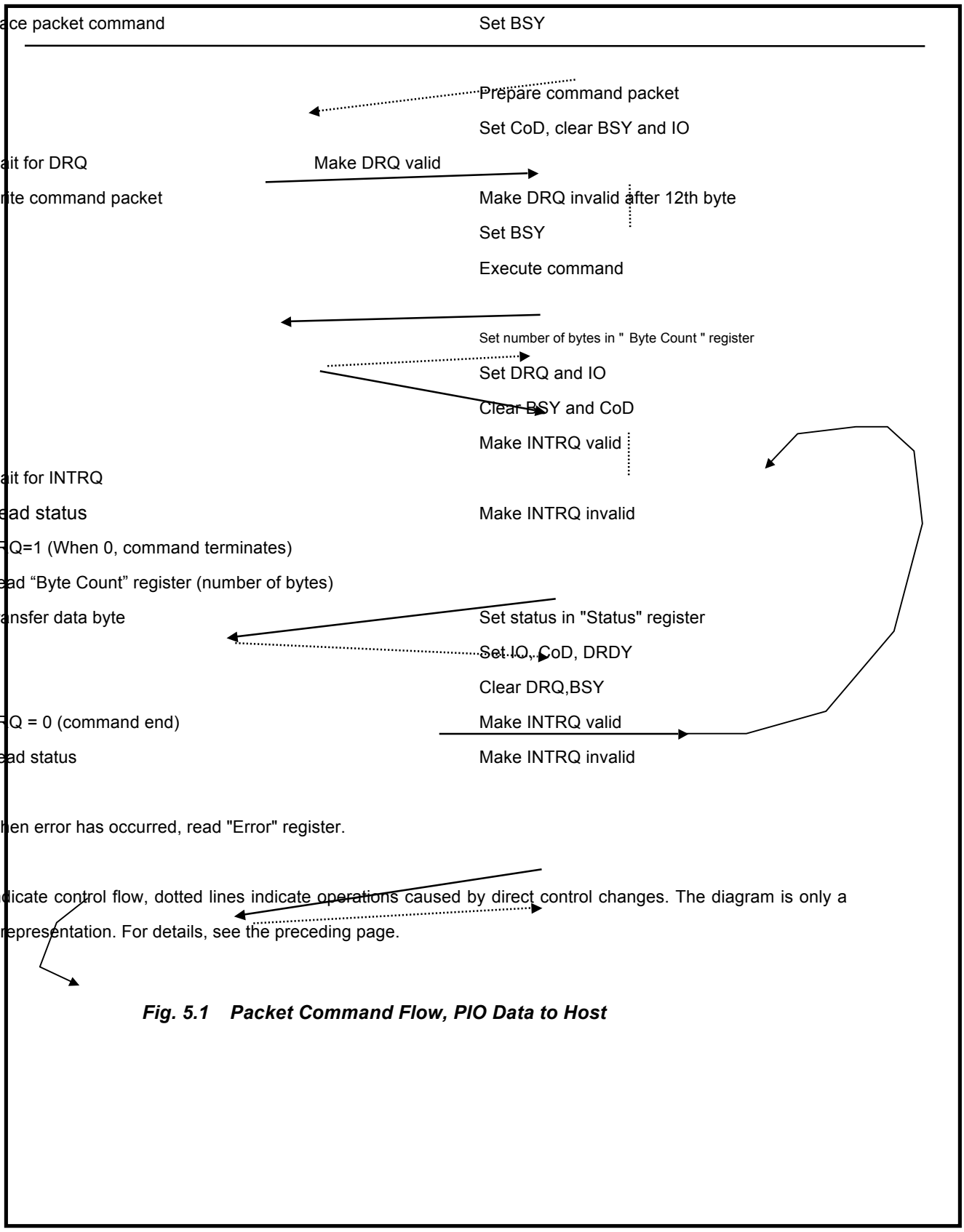
For execution, an unknown number of data bytes is sent from the device to the host.

1. The host polls for the BSY = 0, DRQ = 0 condition, inputs the transfer mode, drive select and other parameters in the "Features", "Byte Count" registers, and initializes the task file.
2. The host writes the packet command code (A0h) in the command register.
3. The device sets the BSY bit (within 400 ns) and prepares for command packet transfer.
4. When the device is ready to receive a command packet, it sets the CoD bit and clears the IO bit. The DRQ bit must be made valid simultaneously or before making the BSY bit invalid.
5. When host polling verifies the DRQ bit, it writes a 12-byte (6-word) packet command to the data register.
6. Device
   (1) DRQ bit i[s cleared (when 12th byte was written).
   (2) BSY bit is set.
   (3) "Features" and "Byte Count" registers are read to determine parameters requested by the host.
   (4) Data transfer preparations are made.
7. When preparations are complete, the following steps are carried out at the device.
   (1) Number of bytes to be read is set in "Byte Count" register.
   (2) IO bit is set and CoD bit is cleared.
   (3) DRQ bit is set, BSY bit is cleared.
   (4) INTRQ is set, and a host interrupt is issued.
8. After checking INTRQ, the DRQ bit of the "Status" register is read, to determine whether the host can continue to send commands.
   DRQ = 0: Device has executed command.
   DRQ = 1: Host must read data (distinct byte numbers in "Byte Count" register) via "Data" register.
   When host reads the "Status" register, the device makes the INTRQ bit invalid.
9. When the host has sent entire data, the device clears the DRQ bit. If more data are to be sent, the device sets the BSY bit and repeats the above sequence from step 7.

10. When the device is ready to send the status, it writes the final status to the "Status" register. CoD, IO, DRDY are set (before making INTRQ valid), and BSY and DRQ are cleared.
11. After verifying that INTRQ & DRQ = 0, read the Status register on the host. If the Check bit is set, read the command completion status from the Error register.

Note: The DRQ signal is used by the device to indicate that it is ready for data transfer. It is cleared after the last data byte has been sent.

Note: During data transmission, if data transmission amount is 0 in the command, DRQ=0 is indicated in step 8 and termination is normal.



olid lines indicate control flow, dotted lines indicate operations caused by direct control changes. The diagram is only a ugh visual representation. For details, see the preceding page.

Fig. 5.1 Packet Command Flow, PIO Data to Host

7.2 Transfer Packet Command Flow For PIO Data from Host

This class includes the following command.

- SET_MODE

For execution, a known number of data bytes is sent from the host to the device.

1 The host polls for the BSY = 0, DRQ = 0 condition, inputs the transfer mode, drive select and other parameters in the "Features", "Byte Count" registers, and initializes the task file.

2 The host writes the packet command code (A0h) in the command register.

3 The device sets the BSY bit (within 400 ns) and prepares for command packet transfer.

4 When the device is ready to receive a command packet, it sets the CoD bit and clears the IO bit. The DRQ bit must be made valid simultaneously or before making the BSY bit invalid.

5 When host polling verifies the DRQ bit, it writes a 12-byte (6-word) packet command to the data register.

6 Device

(1) DRQ bit is cleared (when 12th byte was written).

(2) BSY bit is set.

(3) "Features" and "Byte Count" registers are read to determine parameters requested by the host.

(4) Data transfer preparations are made.

7 When preparations are complete, the following steps are carried out at the device.

(1) Number of bytes to be read is set in "Byte Count" register.

(2) IO bit is set and CoD bit is cleared.

(3) DRQ bit is set, BSY bit is cleared.

(4) INTRQ is set, and a host interrupt is issued.

The number of bytes normally is the byte number in the register at the time of receiving the command, but it may also be the total of several devices handled by the buffer at that point.

8 After checking INTRQ, the DRQ bit of the "Status" register is read, to determine whether the host can continue to send commands.

DRQ = 0: Device has executed command.

DRQ = 1: Host must read data (distinct byte numbers in "Byte Count" register) via "Data" register.

When host reads the "Status" register, the device makes the INTRQ bit invalid.

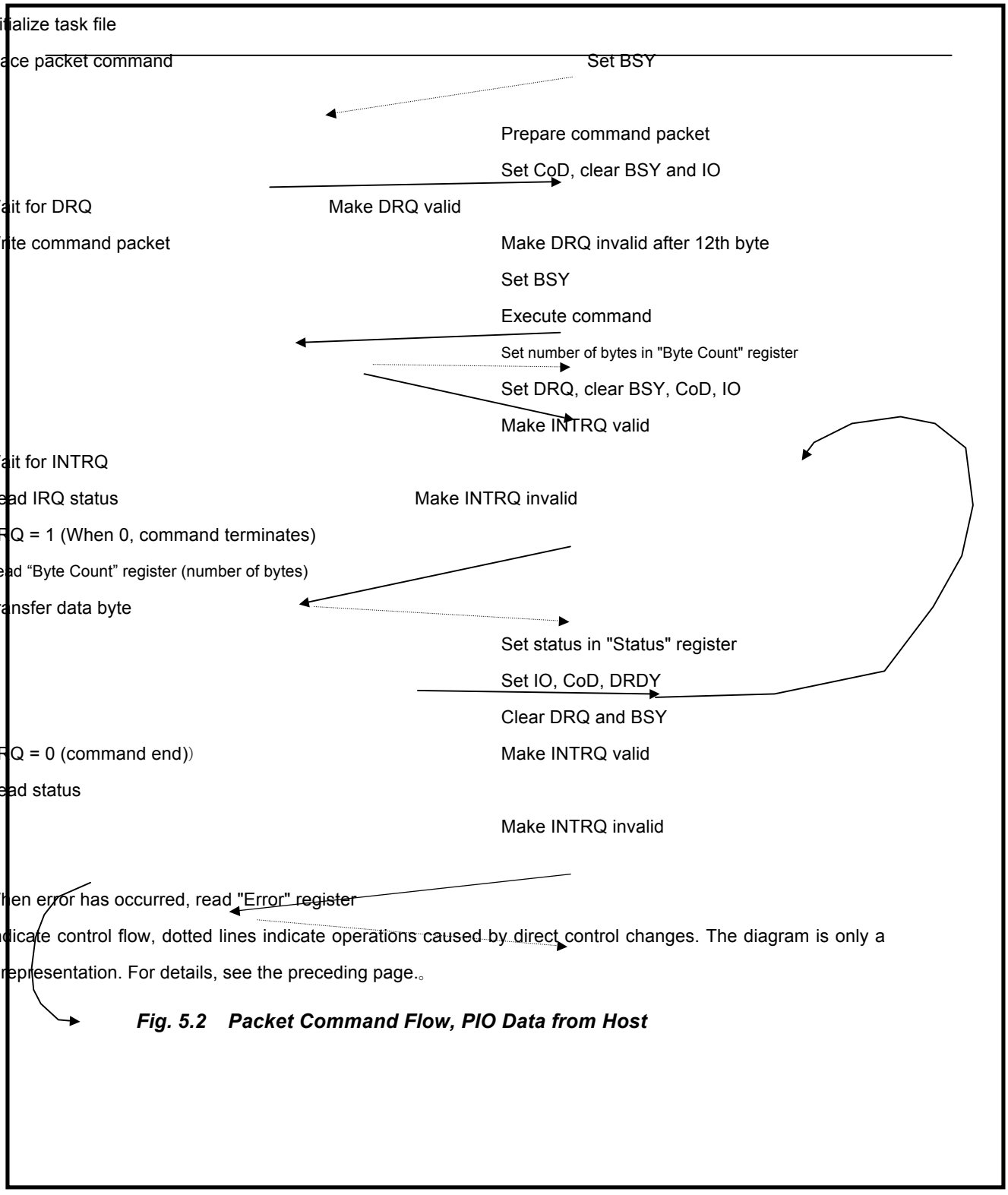
9 When the host has sent entire data, the device clears the DRQ bit. If more data are to be sent, the device sets the BSY bit and repeats the above sequence from step 7.

10 When the device is ready to send the status, it writes the final status to the "Status" register. CoD, IO, DRDY are set (before making INTRQ valid), and BSY and DRQ are cleared.

11 After verifying that INTRQ & DRQ = 0, the host reads the "Status" register and reads the command completion status from the "Error" register if required.

The DRQ signal is used by the device to indicate that it is ready for data transfer. It is cleared after the last data byte has been sent.

Note: During data transmission, if data transmission amount is 0 in the command, DRQ=0 is indicated in step 8 and termination is normal.



olid lines indicate control flow, dotted lines indicate operations caused by direct control changes. The diagram is only a ugh visual representation. For details, see the preceding page.

Fig. 5.2 Packet Command Flow, PIO Data from Host

7.3 DMA Command Flow

This class includes the following commands.

- CD_READ
- CD_READ2

For execution, an unknown number of data bytes is sent from the host to the device.

1. The host polls for the BSY = 0, DRQ = 0 condition and initializes the task file for writing the required parameters in the "Features" and "Byte Count" registers.
2. The host writes the packet command code (A0h) in the command register.
3. The device sets the BSY bit (within 400 ns) and prepares for command packet transfer.
4. When the device is ready to receive a command packet, it sets the CoD bit and clears the IO bit. The DRQ bit must be made valid simultaneously or before making the BSY bit invalid.
5. When host polling verifies the DRQ bit, it writes a 12-byte (6-word) command to the data register.
6. Device
   (1) DRQ bit is cleared (when 12th byte was written).
   (2) BSY bit is set.
   (3) "Features" and "Byte Count" registers are read to determine parameters requested by the host.
   (4) Preparations for data transfer are made.
7. When preparations are complete, the device sends several data packets using DMARQ/DMACK. The packets must be managed by the device and possibly placed in its own buffer. This process continues until all data are sent.
8. When the device is ready to send the status, it writes the final status (IO, CoD, DRDY set, BSY, DRQ cleared) to the "Status" register before making INTRQ valid.
   After checking INTRQ, the host reads the "Status" register to check the completion status.

Note: During data transmission, if data transmission amount is 0 in the command, DMARQ/DMACK is not carried out in step 7 but INTRQ is enabled and termination is normal.

7.4 Non-Data Command Flow

This class includes the following commands.

- TEST_UNIT
- CD_OPEN
- CD_PLAY
- CD_SEEK
- CD_SCAN

No data transfer accompanies the issue of these commands.

This class includes commands such as Seek. For execution, no data bytes are sent.

1. The host polls for the BSY = 0, DRQ = 0 condition and initializes the task file for writing the required parameters in the "Features" and "Byte Count" registers.
2. The host writes the packet command code (A0h) in the command register.
3. The device sets the BSY bit and prepares for command packet transfer.
4. When the device is ready to receive a command packet, it sets the CoD bit and clears the IO bit. The DRQ bit must be made valid simultaneously or before making the BSY bit invalid.
5. When host polling verifies the DRQ bit, it writes a 12-byte (6-word) command to the data register.
6. The device sets the BSY bit and executes the command.
7. When the device is ready to send the status, it writes the final status (IO, CoD, DRDY set, BSY, DRQ cleared) to the "Status" register before making INTRQ valid.

After checking INTRQ, the host reads the "Status" register to check the completion status.

8. SPI Packet Commands

Table 6.1 List of Commands

Command	Function	Op code
TEST_UNIT	Verify access readiness	00h
REQ_STAT	Get CD status	10h
REQ_MODE	Get various settings	11h
SET_MODE	Make various settings	12h
REQ_ERROR	Get error details	13h
GET_TOC	Get all TOC data	14h
REQ_SES	Get specified session data	15h
CD_OPEN	Open tray	16h
CD_PLAY	Play CD	20h
CD_SEEK	Seek for playback position	21h
CD_SCAN	Perform scan	22h
CD_READ	Read CD	30h
CD_READ2	CD read (pre-read position)	31h
GET_SCD	Get subcode	40h

8.1 Command Packet Format

Bit Byte	7	6	5	4	3	2	1	0
0	Command code							
1	Command parameter							
2	Command parameter							
3	Command parameter							
4	Command parameter							
5	Command parameter							
6	Command parameter							
7	Command parameter							
8	Command parameter							
9	Command parameter							
10	Command parameter							
11	Command parameter							

- Command codes

  The codes allotted to the various commands required to control the devices.

- Command parameter

  Transfer Length

  The transfer length field indicates the data length that ought to be transferred, and it normally indicates the block count. However, in the case of several commands, it indicates the transfer byte count defined during description of the command. For details, refer to the explanations of the individual commands.

  For commands with multiple byte transfers, the transfer length "0" indicates no transfer.

  Allocation Length

  The allocation length field indicates the maximum length of the data that the host can receive. The allocation length "0" indicates no transfer. When the device has completed transfer of the allocated byte length, or when it has completed transfer of valid data to the host, it terminates data transfer. The allocation length is used to control the maximum data length that can be returned to the host.

  Starting Address

  Indicates from which position among the entire data that data transfer should start. In some cases it may simply indicate the transfer starting address. For details, refer to the explanations of the individual commands.

8.2 Command Reference

Common to all CD blocks : Check access readiness

Command name: TEST_UNIT (00h)

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0

Operation:

Verifies that the device can be accessed.

Description:

This device does not report the check condition status. When this command is received, it reports the GOOD status.

If the device cannot become operative or cannot be set to the ready state, the sense key reports the "NOT READY" check condition.

When the host performs polling, this command is valid until the device becomes ready. It is especially useful for checking the media.

Common to all CD blocks : Get CD status

Command name: REQ_STAT (10h)

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	0	1	0	0	0	0
1	0	0	0	0	0	0	0	0
2	Starting Addres							
3	0	0	0	0	0	0	0	0
4	Allocation Length							
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0

Operation:

Gets current CD status information (status and report).

Description:

Starting Address (Byte 2)

Specifies start address of requested information. Must always be an even address.

Allocation Length (Byte 4)

Specifies data length of requested information. When allocation length is zero, no data are sent.

CD status information

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	0	0	STATUS			
1	Disc Format				Repeat Count			
2	Address				Control			
3	TNO							
4	X							
5	FAD							
6	FAD							
7	FAD							
8	Max Read Error Retry Times							
9	0	0	0	0	0	0	0	0

Description:

- STATUS

00h	<BUSY>	State transition
01h	<PAUSE>	Pause
02h	<STANDBY>	Standby (drive stop)
03h	<PLAY>	CD playback
04h	<SEEK>	Seeking
05h	<SCAN>	Scanning
06h	<OPEN>	Tray is open
07h	<NODISC>	No disc
08h	<RETRY>	Read retry in progress (option)
09h	<ERROR>	Reading of disc TOC failed (state does not allow access)

- Disc Format (Byte 1, Bit 7-4)

Indicates the type of CD.

Bit7	Bit6	Bit5	Bit4	Disc Format
0	0	0	0	CD-DA
0	0	0	1	CD-ROM
0	0	1	0	CD-ROM XA, CD Extra
0	0	1	1	CD-I
1	0	0	0	GD-ROM

- Repeat Count (Byte 1, Bit 3 - 0)

  Number of remaining repeat cycles. The information range is 0 to Eh (0 - 14 times), Fh becomes unlimited repeat.

- Control Address (Byte 2)

  Control address byte of subcode Q (first byte)

- TNO (Byte 3)

  Subcode Q track number (binary value, not BCD)

- X (Byte 4)

  Subcode Q index number (binary value, not BCD)

- FAD (Byte 5-7)

  Frame address (based on subcode Q for CD-DA and header information for CD-ROM)

Drive status and FAD

Drive status	Disc Format
<BUSY>	Undefined
<PAUSE>	Subcode value obtained when the head has moved to the head position for pausing <PAUSE> state.
<STANDBY>	Home position (96h)
<PLAY>	Head position before head travel, or the current head position.
<SEEK>	Head position before head travel.
<SCAN>	Head position before head travel, or current head position.
<OPEN>	Home position (96h)
<NODISC>	Home position (96h)
<RETRY>	Head position before head travel.
<ERROR>	Home position (96h)

- Max Read Error Retry Times (Byte 8)

  Indicates how many read retries were necessary.

  This item is cleared (set to 0) when read.

Common to all CD blocks : Get mode information

Command name: REQ_MODE (11h)

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	0	1	0	0	0	1
1	0	0	0	0	0	0	0	0
2	Starting Addres							
3	0	0	0	0	0	0	0	0
4	Allocation Length							
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0

Operation:

Gets CD block mode information.

Description:

Starting Address (Byte 2)

Start address of requested information. Must always be an even address.

Allocation Length (Byte 4)

Data length of requested information. When allocation length is zero, no data are sent.

Hardware information

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	CD-ROM Speed							
3	0	0	0	0	0	0	0	0
4-5	Standby Time							
6	0	0	Read Continuous	ECC (Option)	Read Retry	0	0	Form2 Read Retry
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	Read Retry Times							
10-17	Drive Information (ASCII)							
18-25	System Version (ASCII)							
26-31	System Date (ASCII)							

Description:

- CD-ROM speed (byte 2)

  CD-ROM data read rate

Byte2	Speed
0	Maximum speed
1	Standard speed (option)
2	x2 (option)
3	x4 (option)
4	x6 (option)
5	x8 (option)
6	x10 (option)
7	x12 (option)

  The default value of this item is 00h (max. speed).

- Standby Time (Byte 4-5)

  Time required to trigger change from pause to standby.

  When the pause state continues for this interval, the unit switches to standby. The value is set as a 16-bit value with byte 4 as MSB and byte 5 as LSB.

Standby time value	Operation
0	Unlimited (no switch from pause to standby)
1~FFFFh	Switch to standby after specified number of seconds

  Note: When this parameter is too large, the MTBF may be negatively affected.

  Default is B4h (3 minutes).

- Read Continuous (Byte 6, Bit 5)

  This bit determines whether continuity or retry has priority during data transfer. When the bit is set to "1", playback is carried out without delay due to error recovery. In this case, the data stream may contain errors.

  When the bit is set to "1", "Read Retry Times" and similar parameters are irrelevant.

  The default value of this item is "0".

- ECC (Byte 6, Bit 4) (Option)

  When this bit is set to 1, retry is performed if an error has occurred during ECC processing.

  (Valid only in Mode 1 or Mode 2, Form 1.)

  The default value of this item is "1".

- Read Retry (Byte 6, Bit 3)

  When this bit is set to "1", read retry is carried out when a sector read error has occurred, according to the "Read Retry Times" setting.

  The default value of this item is "1".

- Form 2 Read Retry (Byte 6, Bit 0)

  When 1 is set for this bit, read retry is set for Mode 2, Form 2.

  The default value of this item is "1".

- Read Retry Times (Byte 9)

  Same-sector read retry count for CD-ROM decoding. (Valid only in Mode 1 or Form 1.) Read retry is not conducted when set to 0h.

  Note: When flag setting is "Form 2 Read Retry = 1" (Form 2 read retry ON), this applies also to Form 2.

  The default value of this item is "08h".

- Drive Information (Byte 10 - 17) Read Only

  Name of drive (ASCII).

  This item can only be read.

- System Version (Byte 18 - 25) Read Only

  CD block version (ASCII).

  This item can only be read.

- System Date (Byte 26 - 31) Read Only

  Updated date of CD block (ASCII).

  This item can only be read

Common to all CD blocks: Set mode

Command name: SET_MODE (12h)

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	0	1	0	0	1	0
1	0	0	0	0	0	0	0	0
2	Starting Addres							
3	0	0	0	0	0	0	0	0
4	Allocation Length							
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0

Operation:

Sets CD block mode information.

Description:

Starting Address (byte 2)

Start address of requested information. Must always be an even address.

Allocation Length (byte 4)

Data length of requested information. When allocation length is zero, no data are sent.

For information on the transfer data format, refer to the "REQ_MODE" section.

It is recommended to read the current parameters with "REQ_MODE" before using the "SET_MODE" command. Read-only items are not included in the data setting alternatives.

Common to all CD blocks: Get error information

Command name: REQ_ERROR (13h)

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	0	1	0	0	1	1
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	Allocation Length							
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0

Operation:

Requests transfer of device error information to the host.

This command must be issued so that the host can receive sense data indication error causes whenever an error has been reported. When another command is issued, error information is cleared.

Description:

Allocation Length (Byte 4)

Data length of requested information. When allocation length is zero, no data are sent.

Error Information

Bit Byte	7	6	5	4	3	2	1	0
0	1	1	1	1	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	Sense Key			
3	0	0	0	0	0	0	0	0
4-7	Command Specific Information							
8	Additional Sense Code							
9	Additional Sense Code Qualifier							

Description:

- Sense Key (Byte 2, Bits 3 - 0)

  The sense key field contains general information on error status or exceptional state. The sense key, additional sense code, and additional sense code qualifier provide hierarchically structured information. This makes it possible to configure a top-down approach in the host for error and exception processing.

  For detailed information on the sense keys, refer to Table 3.2.

- Command Specific Information (Byte 4 - 7)

  This field contains information about the executed command. Details are described in the sections on the respective commands.

  If not defined by a command, the FAD where the error occurred is reported.

- Additional Sense Code (Byte 8)

  Additional Sense Code (ASC) field contains more detailed information about error and exception conditions than the sense key field.

  Refer to Appendix I for concrete information on the contents of Additional Sense Code.

- Additional Sense Code Qualifier (Byte 9)

  Additional Sense Code Qualifier (ASCQ) field contains additional information about the additional sense code.

  Refer to Appendix I for concrete information on the contents of Additional Sense Code Qualifier.

Common to all CD blocks: Get all TOC data

Command name: GET_TOC (14h)

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	0	1	0	1	0	0
1	0	0	0	0	0	0	0	Select
2	0	0	0	0	0	0	0	0
3	Allocation Length (MSB)							
4	Allocation Length (LSB)							
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0

Operation:

Requests transfer of entire TOC (102 entries).

Description:

Select (Byte 1, Bit 0)

Selects the type of volume.

0: Get TOC information from single-density area.

1: Get TOC information from double-density area.

Allocation Length (Byte 4)

Data length of requested information. When allocation length is zero, no data are sent.

Entire TOC information

Bit Byte	7	6	5	4	3	2	1	0
0~3	Track 1 information *1							
4~7	Track 2 information							
n~n+3	Track n information							
396~399	Start track information *2							
400~403	End track information *3							
404~407	Lead-out information *4							

Track information *1

Bit Byte	7	6	5	4	3	2	1	0
0	Control				ADR			
1	FAD for track 1 start (MSB)							
2	FAD for track 1 start							
3	FAD for track 1 start (LSB)							

The track FFFFFFh does not exist the TOC.

Start track information *2

Bit Byte	7	6	5	4	3	2	1	0
0	Control				ADR			
1	Start track number							
2	0							
3	0							

End track information *3

Bit Byte	7	6	5	4	3	2	1	0
0	Control				ADR			
1	End track number							
2	0							
3	0							

Lead-out information *4

Bit Byte	7	6	5	4	3	2	1	0
0	Control				ADR			
1	FAD for lead-out start (MSB)							
2	FAD for lead-out start							
3	FAD for lead-out start (LSB)							

For multi-session discs, this is the value for the last session.

ADR (Byte 0, Bit 0 - 3)

This item indicates the type of information encoded in the sub Q channel of the block for which a TOC entry was detected.

ADR code	Description
0h	No sub Q channel mode information
1h	Sub Q channel indicates current position. (Example: track, index, absolute address, relative address)
2h	Sub Q channel indicates media catalog number.
3h	Sub Q channel indicates ISRC code.
4h~Fh	Reserved

Control (Byte 0, Bit 4 - 7)

This item indicates the type of track.

Bit	If 0	If 1
0	Audio data without pre-emphasis (CD-DA) At-once recorded track (CD-ROM)	Audio data with pre-emphasis (CD-DA) Packet-recorded track (CD-ROM
1	Digital copy prohibited	Digital copy allowed
2	Audio track	Data track
3	2-channel audio	4-channel audio

Common to all CD blocks: Get specified session data

Command name: REQ_SES (15h)

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	0	1	0	1	0	1
1	0	0	0	0	0	0	0	0
2	Session Number							
3	0	0	0	0	0	0	0	0
4	Allocation Length							
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0

Operation:

Requests transfer of specified session information (on multi-session CD)

Description:

Session Number (Byte 2)

Session number (0 - 99)

Allocation Length (Byte 4)

Data length of requested information. When allocation length is zero, no data are sent.

Entire TOC

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	0	0	STATUS			
1	0	0	0	0	0	0	0	0
2	Number of Session/Starting TNO							
3	Lead out FAD/Starting FAD							
4	Lead out FAD/Starting FAD							
5	Lead out FAD/Starting FAD							

Description:

- STATUS (Byte 0, Bit 0 - 3)

  See description of CD status.

- Number of Session/Starting TNO (byte 2)

  When 00h is specified, the total number of sessions is returned.

- Lead-out FAD/Starting FAD (Byte 3 - 5)

  When 00h is specified, this indicates the lead-out starting FAD. When something else is specified, the start FAD of the specified session is indicated.

Common to all CD blocks: Open tray

Command name: CD_OPEN (16h)

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	0	1	0	1	1	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0

Operation:

Stops the CD drive and opens the tray.

- Automatic (front-loading drive): CD block opens the tray automatically.
- Manual (top-loading drive): busy state is invoked until opened manually.

Note:

- TOC and session information is initialized and returned to the no-data state.

CD drive: Play CD

Command name: CD_PLAY (20h)

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	1	0	0	0	0	0
1	0	0	0	0	0	Parameter Type		
2	Starting Point							
3	Starting Point							
4	Starting Point							
5	0	0	0	0	0	0	0	0
6	Reserve				Repeat Times			
7	0	0	0	0	0	0	0	0
8	End Point							
9	End Point							
10	End Point							
11	0	0	0	0	0	0	0	0

Operation:

CD audio tracks are played back according to the playback parameters.

When this command is issued and executed for a section other than CD-DA, the playback operation is performed but no sound is output (this is not recommended, as noise may be output).

Playable areas are limited to continuous areas within the disc's program area. If the play request's starting frame address is equal to most peripherical lead-out start address, or exceeding is this, it is regarded as an abnormal request.

Play operation stops if the lead-out area is reached during play. If repeated, play stops after one operation.

If intermediate lead-out and lead-in areas are specified as start address on multi-section discs, the actual start address becomes the start of the user program area following the specified start address.

CD playback restart is only possible using this command from the play state, or a pause state following this, or from scan state. In other states, this become an abnormal request.

Description:

- Parameter Type (Byte 1, Bit 0 - 2)

  Indicates the point parameter specification method.

Bit2	Bit1	Bit0	Parameter Type
0	0	1	FAD specified
0	1	0	MSF specified
1	1	1	Start CD playback

- Start Point (Byte 2 - 4)

  Specifies the start point for CD audio playback.

  The specification method depends on the parameter type.

FAD specified

Byte2	Start frame address (MSB)
Byte3	Start frame address
Byte4	Start frame address (LSB)

MSF specified

Byte2	Start time: minutes (binary 0 - 255)
Byte3	Start time: seconds (binary 0 - 59)
Byte4	Start time: frames (binary 0 - 74)

- CD playback start

  Bytes 2 - 4 are reserved.

  CD playback starts from current point without changing the playback range and playback mode. However, when restarting playback following a pause, playback may start from a position slightly different from the pause position.

- Repeat Times (Byte 6, Bit 0 - 3)

  Specifies the number of repeats for playing a CD audio section.

Value	Description
0h	No repeat (one play only)
1h-Eh	Number of repeats (max. 14)
Fh	Endless repeat

- End Point (Byte 8 - 10)

  Specifies the end point for CD audio playback. The specification method depends on the parameter type.

  If "0" is specified as end point, playback continues until immediately before the lead-out section. Also, if the lead-out address is set to the end point, or to an address with a higher value than that, playback continues to the lead-out.

  FAD specified

Byte2	End frame address (MSB)
Byte3	End frame address
Byte4	End frame address (LSB)

  MSF specified

Byte2	End time: minutes (binary 0 - 255)
Byte3	End time: seconds (binary 0 - 59)
Byte4	End time: frames (binary 0 - 74)

- CD playback start

  Bytes 8 - 10 are reserved.

CD drive: Seek playback position

Command name: CD_SEEK (21h)

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	1	0	0	0	0	1
1	0	0	0	0	Parameter Type			
2	Seek Point							
3	Seek Point							
4	Seek Point							
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0

Operation:

Pickup moves to specified playback position and then goes into pause mode.

In the case of FAD/MSF, the Parameter Type specification is regarded as an abnormal request if the seek address is smaller than the starting address (00:02:00) of the perimeter user program area, or equal to the starting address of the perimeter user program area, or larger than this.

Description:

- Parameter Type (Byte 1, Bit 0 - 2)

  Indicates the point parameter specification method.

Bit2	Bit1	Bit0	Parameter Type
0	0	1	FAD specified
0	1	0	MSF specified
0	1	1	Stop playback (move to home position)
1	0	0	Pause playback (seek position is unchanged)

- Seek Point (Byte 2 - 4)

  Specifies the start point.

  The specification method depends on the parameter type.

  FAD specified

Byte2	Seek frame address (MSB)
Byte3	Seek frame address
Byte4	Seek frame address (LSB)

  MSF specified

Byte2	Seek time: minutes (binary 0 - 255)
Byte3	Seek time: seconds (binary 0 - 59)
Byte4	Seek time: frames (binary 0 - 74)

- CD playback stop or CD playback pause

  Bytes 2 - 4 are reserved.

CD drive: Scan playback

Command name: CD_SCAN (22h)

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	1	0	0	0	1	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	Direction
3	SPEED							
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0

Operation:

Causes CD scan playback. Continues until another CD drive command (play, seek) is issued. When lead-in area or lead-out area is reached during scan, pause mode is activated.

This command is only accepted in the play state following the CD_PLAY command, or a pause state following this, or from scan state. In other states, this become an abnormal request.

Description:

- Direction (Byte 2, Bit 0)

  Indicates the direction for scan playback .

  0 = Fast-forward

  1 = Fast-reverse

- Speed (Byte 3)

  Playback is carried out at the specified speed (x1 rotation times).

  Speeds that can be specified

Specified value	Playback speed
0−2	2x
3−5	5x
6−9	9x
10−	16x

CD drive: CD data read

Command name: CD_READ (30h)

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	1	1	0	0	0	0
1	Data Select				Expected Data Type			Parameter Type
2	Starting Addres (MSB)							
3	Starting Addres							
4	Starting Addres (LSB)							
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	Transfer Length (MSB)							
9	Transfer Length							
10	Transfer Length (LSB)							
11	0	0	0	0	0	0	0	0

Operation:

The specified data are read from the CD.

This is regarded as an abnormal request if the read starting address is smaller than the starting address (00:02:00) of the user program area, or equal to the starting address of the perimeter user program area, or larger than this.

Description:

- Data Select (Byte 1, Bit 7 - 4)

Bit7	Bit6	Bit5	Bit4
Header	Sub header	Data	Other

Selects the desired data by a combination of the above bits.

* Data combinations must use a continuous area. For example, in a format that includes a subheader, it is not possible to omit the subheader.
* When the "Other" bit is selected, all data (2352 bytes) are output.
* When Data Type is CD-DA, this specification is invalid, and 2352 bytes are always transferred.

- Expected Data Type (Byte 1, Bit 3 - 1)

The expected sector type is used to limit information read by the host. If the requested sector does not conform to the specified type, the command terminates with an error. It the disc is an XA disc type, an error is generated if mode 2nonXA is specified.

Bit3	Bit2	Bit1	Definition	Description
0	0	0	Any type	No check for sector type. However, if reading of mode 2 track or Form 1/Form 2 is attempted in the case of a disc which is not a CD-ROM XA, the Mode 2 disc reading will fail.
0	0	1	CD-DA	CD-DA Error if sector other than CD-DA is read.
0	1	0	Mode 1	Mode 1 Error if sector other than 2048 byte (Yellow Book) is read
0	1	1	Mode 2	Mode 2, Form 1 or Mode 2, Form 1 Error if sector other than 2336 byte (Yellow Book) is read

1	0	0	Mode 2, Form 1	Mode 2, Form 1. Error if sector other than 2048 byte (Green Book) is read
1	0	1	Mode 2, Form 2	Mode 2, Form 1 Error if sector other than 2324 byte (Green Book) is read
1	1	0	Mode 2 Non XA	Mode 2 of non-CD-ROM XA disc 2336 bytes are read. No sector type check is performed

When Mode 2 has been specified, a Sub Header is also automatically transferred when data is specified in Data Select. Also, when the data is Form 1, 28 bytes are added as dummy bytes for the transmission and when the data is Form 2, 4 bytes are added as dummy bytes.
It should be noted that because sector type check is not performed the error correction function does not work for the CD-ROM.

- Parameter Type (Byte 1, Bit 0)

Bit0	Parameter Type
0	FAD specified
1	MSF specified

- Start Point (Byte 2 - 4)

  Specifies the start point for CD data read.

  The specification method depends on the parameter type.

  FAD specified

Byte2	Start frame address (MSB)
Byte3	Start frame address
Byte4	Start frame address (LSB)

  MSF specified

Byte2	Start time: minutes (binary 0 - 255)
Byte3	Start time: seconds (binary 0 - 59)
Byte4	Start time: frames (binary 0 - 74)

- Transfer Length (byte 8 - 10)

  Specifies the number of sectors to be transferred.

Byte8	Number of transfer sectors (MSB)
Byte9	Number of transfer sectors
Byte10	Number of transfer sectors (LSB)

CD drive: CD data read 2

Command name: CD_READ (31h)

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	1	1	0	0	0	1
1	Data Select				Expected Data Type			Parameter Type
2	Starting Addres (MSB)							
3	Starting Addres							
4	Starting Addres (LSB)							
5	0	0	0	0	0	0	0	0
6	Transfer Length (MSB)							
7	Transfer Length (LSB)							
8	Next Address (MSB)							
9	Next Address							
10	Next Address (LSB)							
11	0	0	0	0	0	0	0	0

Operation:

The specified data are read from the CD.

Because the pre-read position can be specified, next- access efficiency is improved. For the pre-read position, no error is reported. An error occurring at the pre-read position is reported the next time the pre-read position is specified with the read command.

This is regarded as an abnormal request if the starting address or the pre-read address is smaller than the starting address (00:02:00) of the user program area, or it is equal to or larger than the starting address of the perimeter user program area.

Description:

- Data Select (Byte 1, Bit 7 - 4)

Bit7	Bit6	Bit5	Bit4
Header	Sub header	Data	Other

Selects the desired data by a combination of the above bits.

* Data combinations must use a continuous area. For example, in a format that includes a subheader, it is not possible to omit the subheader.
* When the "Other" bit is selected, all data (2352 bytes) are output.
* When Data Type is CD-DA, this specification is invalid, and 2352 bytes are always transferred.

- Expected Data Type (Byte 1, Bit 3 - 1)

The expected sector type is used to limit information read by the host. If the requested sector does not conform to the specified type, the command terminates with an error. When the disc type is XA, an error occurs if Mode 2 non XA is specified.

Bit3	Bit2	Bit1	Definition	Description
0	0	0	Any type	Sector type is not checked. However, if reading of mode 2 track or Form 1/Form 2 is attempted in the case of a disc which is not a CD-ROM XA, the Mode 2 disc reading will fail.
0	0	1	CD-DA	CD-DA Error if sector other than CD-DA is read
0	1	0	Mode 1	Mode 1

				Error if sector other than 2048 byte (Yellow Book) is read
0	1	1	Mode 2	Mode 2 Form 1 or Mode 2 Form1 Error if sector other than 2336 byte (Yellow Book) is read
1	0	0	Mode 2, Form 1	Mode 2 Form 1 Error if sector other than 2048 byte (Green Book) is read
1	0	1	Mode 2, Form 2	Mode 2 Form 1 Error if sector other than 2324 byte (Green Book) is read
1	1	0	Mode 2 non XA	Mode 2 of non-CD-ROM XA disc 2336 bytes are read. No sector type check is performed

When Mode 2 has been specified, a Sub Header is also automatically transferred when data is specified in Data Select. Also, when the data is Form 1, 28 bytes are added as dummy bytes for the transmission and when the data is Form 2, 4 bytes are added as dummy bytes.

It should be noted that because sector type check is not performed the error correction function does not work for the CD-ROM.

- Parameter Type (Byte 1, Bit 0)

  Determines how the point parameter is specified.

Bit0	Parameter Type
0	FAD specified
1	MSF specified

- Starting Address (Byte 2 - 4)

  Specifies the start point for CD data read.

  The specification method depends on the parameter type.

  FAD specified

Byte2	Start frame address (MSB)
Byte3	Start frame address
Byte4	Start frame address (LSB)

  MSF specified

Byte2	Start time: minutes (binary 0 - 255)
Byte3	Start time: seconds (binary 0 - 59)
Byte4	Start time: frames (binary 0 - 74)

- Transfer Length (Byte 6 - 7)

  Specifies the number of sectors to be transferred

Byte6	Number of transfer sectors (MSB)
Byte7	Number of transfer sectors (LSB)

- Next Address (Byte 8 - 10)

  Specifies the address from which data are to be read after the current data are read.

  The specification method depends on the parameter type.

FAD specified

Byte8	Start frame address (MSB)
Byte9	Start frame address
Byte10	Start frame address (LSB)

MSF specified

Byte8	Start time: minutes (binary 0 - 255)
Byte9	Start time: seconds (binary 0 - 59)
Byte10	Start time: frames (binary 0 - 74)

Subcode: Get subcode

Command name: CD_SCD (40h)

Bit Byte	7	6	5	4	3	2	1	0
0	0	1	0	0	0	0	0	0
1	0	0	0	0	Data Format			
2	0	0	0	0	0	0	0	0
3	Allocation Length (MSB)							
4	Allocation Length (LSB)							
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0

Operation:

Gets subcode information. Because the subcode information is updated approximately every 13.3 ms, the data may be wiped out unless the subcode is read out as fast as possible when subcode is used. Other subcode information than that for Subcode Q does not comprise CRC check and is therefore not very reliable.

Description:

- Data Format (Byte 1, Bit 0 - 3)

Specifies the requested subcode information.

Data Format	Data type	Number of transfer bytes
0h	All subcode information is transferred as raw data	96
1h	Subcode Q data only	12
2-h	Media catalog number (UPC/bar code)	
3-h	International standard recording code (ISRC)	
4-Fh	Reserved	

(0) Format when all subcode information is transferred

Byte	
0	Reserved
1	Audio status
2 3	Subcode data length (100 = 64h)
4~99	Subcode

During audio playback, Subcodes P-W corresponding to the main channel data being output are transferred.

(1) Format for returning Q subcode data

Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Audio status							
2	DATA Length MSB (0 = 0h)							
3	DATA Length LSB (14 = Eh)							
4	Control				ADR			
5~13	DATA-Q							

The Subcode Q value corresponding to the current head position is transferred.

Depending on ADR, there are 3 modes for DATA-Q contents.

- When ADR = 1

Byte	Description							
0	Control				1(ADR)			
1	TNO							
2	X							
3-5	Elapsed FAD within track							
6	0	0	0	0	0	0	0	0
7-9	FAD							

- TNO (Byte 1)

  Indicates the track number.

  00: Lead-in track

  01 - 99:

  AA: Lead-out track

- X (Byte 2)

  00: Pause area

  01 - 99: Index number

Audio status

The audio status field indicates the audio playback operation status, as listed below. 13h and 14h indicate the result of the preceding audio playback operation. This is reported only once. If no audio playback operation is requested, the audio status returned by subsequent READ SUB-CHANNEL commands is 15h. The audio status becomes 15h when reset operation, read operation or seek operation is executed.

Status	Description
00h	Audio status byte not supported or invalid
11h	Audio playback in progress
12h	Audio playback paused
13h	Audio playback ended normally
14h	Audio playback ended abnormally (error)
15h	No audio status information

(2) Media catalog number data format

Byte Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Audio status							
2	Data Length MSB (0 = 0h)							
3	Data Length LSB (24 = 18h)							
4	Format Code (02h)							
5	0							
6	0							
7	0							
8	MCVal	Reserved (o)						
9	N1 (Most significant)							
10	N2							
11	N3							
12	N4							
13	N5							
14	N6							
15	N7							
16	N8							
17	N9							
18	N10							
19	N11							
20	N12							
21	N13							
22	ZERO							
23	Aframe (Binary)							

Description

- MCVal (byte 8, bit 7) Media Catalog Number Data Valid

  If the media catalog number field is valid, the MCVal bit is set to 1. If no media catalog number exists, the MCVal bit is set to 0. MCVal bit is set to 0 if the drive fails to find the Media Catalog Number.

- Media Catalog Number (UPC/Bar Code) (byte 9 - 23)

  The media catalog number field contains a number (ASCII code) that indicates the media type. Values other than "0" in this field are controlled by Uniform Product Code Council and Europian Article Number Council.

  When all ASCII values in this field are "0", the media catalog number is not supported.

  When the media catalog number is detected, the MCVal bit is set to "1". If the number cannot be detected, the bit is set to "0", indicating that the media catalog number is not valid.

  The media catalog number as reported by this command when the sub channel data format field is "02h" uses the value from the block which includes the UPC/bar code Q sub channel data. (A common code is used for all media.)

  N1 - N13 are read from the Q channel in mode 2. The data are ASCII codes.

(3) Track international standard recording code format (03h)

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved (00h)							
1	Audio Status							
2	Data Length MSB (0 = 0h)							
3	Data Length LSB (24 = 18h)							
4	Format Code (03h)							
5	0							
6	0							
7	0							
8	TCVal	Reserved (0)						
9	Reserved (0)		I1 : Country Code					
10	Reserved (0)		I2 : (A – Z)					
11	Reserved (0)		I3 : (Owner Code)					
12	Reserved (0)		I4 :					
13	Reserved (0)		I5 : (A - Z,0 – 9)					
14	Reserved (0)		1	1	I6 (Years of Recording)			
15	Reserved (0)		1	1	I7			
16	Reserved (0)		1	1	I8 (Serial Number)			
17	Reserved (0)		1	1	I9			
18	Reserved (0)		1	1	I10			
19	Reserved (0)		1	1	I11			
20	Reserved (0)		1	1	I12			
21	ZERO							
22	Aframe							
23	Reserved (0)							

TCVal (Byte 8, Bit 7)

When an international standard recording code (ISRC) exists, the TCVal bit is set to "1". When no international standard recording code (ISRC) exists, the TCVal bit is set to "0", indicating that the track international standard recording code format is not valid. For this value, data corresponding to the current head position is transferred. Following head movement, TCVal becomes 0 until this data is detected for the position to which the head has moved.

Track international standard recording code (byte 9 - 23)

The track international standard recording code is an international 12-byte ASCII code, followed by 3-byte 30h data (ASCII code "0").

Appendix I Additional Sense Codes

ASC	ASC Q	Sense Key	Description	Major reason Drive	Media	Host
00	00	0	No error to report			
00	00	B	No error to report (option)			
00	14	5	Error during drive playback operation. Drive operation is stopped (option).	◎	◎	
02	00	3	Drive retry failed. Track could not be located.	◎	◎	
04	01	2	Drive is busy. This status is reported only when no command from host can be accepted (until the READY state is established after the lid is closed or during execution of security check by command).			
09	00	4	Track jump was detected (option).	◎	◎	
09	02	4	Focus servo error was detected.	◎	○	
09	03	4	Spindle servo error was detected.	◎		
09	04	4	Laser power control error was detected (option).	◎		
09	90	4	General servo error was detected.	◎	○	
11	00	3	Unrecoverable error was detected.	○	◎	
15	00	4	Seek operation failed (option).	◎	◎	
17	05	1	Specified address mark ID could not be detected, but previous sector address mark was used for recovery. This error is not reported if PER bit is not set to "1" (option).	○	◎	
18	00	1	Data were read with error correction. This error is not reported if PER bit is not set to "1" (option).	○	◎	
18	01	1	Data were read with retry. This error is not reported if PER bit is not set to "1" (option).	○	◎	
20	00	5	Unsupported command was received.			◎
21	00	5	Invalid address was specified.			◎
24	00	5	Command with invalid field was detected (Reserved bit is not "0", etc.)			◎
26	00	5	Invalid parameter was detected.			◎
28	00	6	Disc is inserted at the time of power-on or hard reset. Or the lid was closed no matter whether a disc is inserted or not.			
29	00	6	No disc inserted at the time of power-on, reset or hard reset, or TOC cannot be read. Or soft reset from host no matter whether a disc is inserted or not.			
2C	01	5	Command not supported by inserted media was received.			◎
3A	00	2	Media operation command was received but no media is inserted.			
44	00	4	Internal hardware error was detected (option).	◎		
4E	00	4	New command was received while previous command was still executing.			◎
53	00	B	Load or eject operation failed (option).	◎		
57	00	2	TOC information could not be read from CD media.	◎	◎	
63	00	5	Lead-out area or data track was detected during playback (option).	○	○	◎
64	00	5	CD media header mode is different from specified data.			
92	00	7	Lens or media contamination was detected (option).	◎	◎	
B9	00	B	Error was detected and CD audio playback was stopped	◎	◎	○

			(option).			
BF	00	B	Drive data buffer overflow (option)			◎